AMATEUR WORK

A MONTHLY MAGAZINE OF THE USEFUL ARTS AND SCIENCES

Vol. I. No. 2. BOSTON, DECEMBER, 1901. Ten Cents a Copy

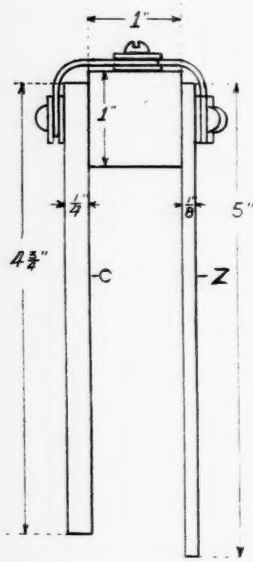
STUDIES IN ELECTRICITY.

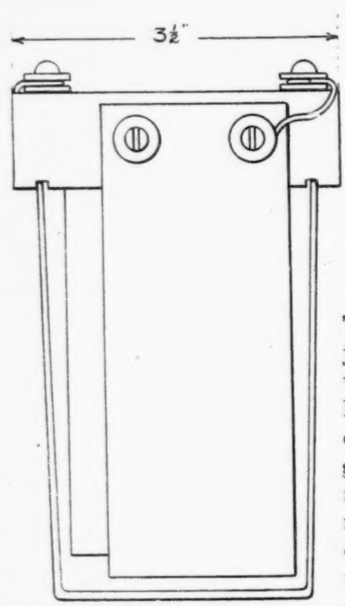
Donald M. Bliss.

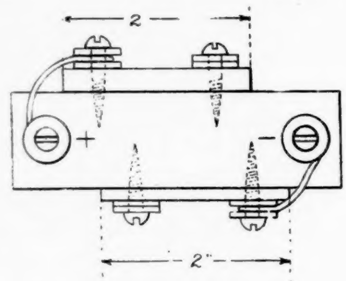
II. Batteries.

The batteries most in practical use may be divided into two classes — single fluid and double fluid cells. The single fluid type consists of two plates of dissimilar metals, or one metal and carbon separated from each other, mounted on a suitable support, and arranged to dip into a jar containing an alkaline or acid solution. A galvanic battery is the name applied to a number of such single cells joined together so as to add their pressures or capacity together. The electrodes or poles of the battery cell are the terminals or binding posts connecting the ends of the plates. In connecting up a battery, it should be remembered that the polarity of any given electrode or binding post is always of the opposite sign to the plate with which it is connected. For instance, in the case of a zinc and carbon cell, the binding post or wire connected to the zinc will be spoken of as the negative pole of the cell, while the zinc itself is the positive element. In these articles, when the term "positive" or "negative" is used in connection with batteries, the polarity of the binding post or wire connecting to the same is always intended. In considering the substances most available for the formation of galvanic cells, the following table includes the most prominent members: 1, zinc; 2, cadmium; 3, tin; 4, lead; 5, iron; 6, nickel; 7, bismuth; 8, antimony; 9, copper; 10, silver; 11, gold; 12, platinum; 13, graphite or carbon. Any two of these metals will form a galvanic cell or couple, and produce a difference of electric potential when immersed in a suitable solution, the first one in the list being the positive element to the next one following, which of course is negative. If, for example, zinc and copper are used, the zinc will be acted on and will form the positive element. The greatest difference of pressure or potential will be developed between Nos. 1 and 13. For experimental purposes, a battery is required which will yield a great amount of current, together with the greatest amount of pressure per cell, and also be able to deliver its output continuously until the solution is exhausted. For the amateur, the type of cell which most nearly fulfills these conditions is known as the bichromate single fluid cell. Fig. 4 shows its construction very clearly, and it consists of a zinc and copper plate screwed to the opposite sides of a wooden cross-bar. Any suitable form of jar may be used, but fruit jars or large glass tumblers of about one pint capacity will be found the cheapest and most convenient. They may be purchased for a few cents each at any corner grocery. The wood cross-bar, it will be noticed, is notched so as to rest firmly on the edges of the bar. The zinc plate should be drilled with two holes, and screwed directly to the cross-bar by small round-headed brass screws, with a copper or brass washer or burr under each screw to give the wire to binding screw a good connection with the plate. The carbon plate must also be fastened to the cross-bar by two similar screws, but care should be taken that the screws of the two plates do not meet and make contact within the cross-bar. This may readily be avoided by not setting the plates exactly opposite each other, but mounting one plate about half an inch to one side of the other, so that the screws will be staggered and cannot touch. Care

should be taken in drilling the carbon plates, as the substance is brittle, and if the drill is forced it is liable to crack the plate. On the top of the cross-bar, at each end, should be driven two more similar screws with two washers under the heads, as shown, and a short piece of copper wire should be connected around the head of one screw on the zinc and under the head of the connecting screw on the top bar. A similar wire should be run from the carbon plate to the remaining binding







screw, as shown. This arrangement is preferable to connecting the wires directly to the plate. After the plates have been mounted in this manner, the cross-bar and the tops of the plates should be dipped in hot melted paraffin for about one inch of their length from the upper end, as shown, and they should be left in the paraffin long enough for it to thoroughly soak into the pores of the wood and carbon. This forms a protection against the corrosion of the acid, which will take place around the screws or in the plates if they are not thus protected. The plates when mounted in position on the bar should reach to within a quarter of an inch from the bottom. The solution used in this form of battery should be made as follows: Take 1 lb. of commercial sulphuric acid. Pour it slowly into one gallon of water, stirring constantly with a glass strip or rod. Some heating will be noticed when the acid is first put into the water. Do not reverse the process and pour the water into the acid, for excessive heat and probable burning will result. Sulphuric acid is a powerful irritant, and care should be taken not to get it in contact with the skin or clothing. After the acid has been added to the water, add twelve ounces of powdered bichromate of potash, and when the solution has cooled, it is ready for use.

The solution may be left in the battery jars, but the plates should be removed when the battery is not actually in use. Before the zinc plates are fastened to the cross-bar, they should be thoroughly amalgamated with mercury. This may be readily done by pouring a small amount of mercury in a saucer or an earthenware dish, and rubbing it on to the zinc plate with a cotton swab, moistened with a solution of sulphuric acid and water. It may take a few minutes for the mercury to start the action, but when once under way it will spread rapidly over the surface of the zinc and form a uniform layer. Both sides of the zinc and the edges should be thus treated, and this process should be renewed when the zincs become badly coated or dirty from continued use. Before starting on the construction of the battery and experimental apparatus described, the student should provide himself with the following list of supplies: 2 lbs. of sulphuric acid, commercial strength, costing from 5 to 8 cts. per lb., 1 lb. bichromate of potash, at 15 to 18 cts. per lb., 1 gross round-head brass screws $\frac{3}{4}''$ long of No. 8 or 10, a few dozen copper burrs or washers, for fitting the screws, 4 lbs. No. 20 single cotton covered magnet wire, 6 zinc plates $5'' \times 2''$, $\frac{1}{16}$ to $\frac{1}{8}''$ thick, costing about

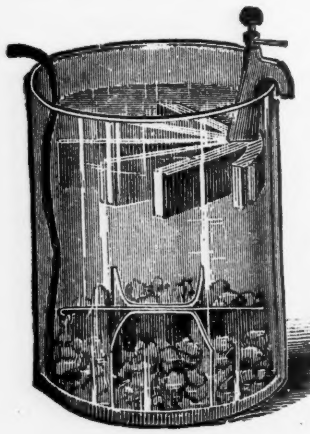
12 cts. per lb., 6 carbon plates same size, costing 8 to 10 cts. apiece, a few lbs. of paraffin wax, and 6 one-pint glass jars. For temporary use, ordinary sheet zinc such as is used by plumbers may be taken instead of regular battery zinc, but the latter is by far the more preferable, on account of its greater thickness and purity. Twenty-five or 50 ft. of No. 14 annunciator or bell wire should also be obtained for convenience in making the various connections between battery and pieces of apparatus.

It will be noted from the sketch that the zinc plate is a little longer than the carbon. As it is advisable to remove the plate from the battery when not in use, the extra length of the zinc plate will protect the carbon to some extent from breaking by frequent handling. A very convenient arrangement for a battery of this sort is to mount the cells on a wooden base, which has at either end an upright post, about 10 or 12 inches high. A rod or a shaft may be fitted in the top of the post and provided with a crank or hand-wheel so as to form a sort of windlass. The crossbars of each cell may all be suspended from a strip of wood which is connected to the shaft by a small chain or cords, and a catch or ratchet wheel should be fitted on the shaft, so that when the battery is not required for use the plates may all be raised above the jars by winding up the supporting chain or cord, and when wanted they may be instantly lowered into the solution. Another arrangement sometimes used is to have a circular wooden base with a post in the center, this post carrying a sliding support to which the plates may be connected.

While the single cell battery just described is perhaps the most convenient for the amateur, owing to ease of construction, compactness and strength, it is not used to any extent in commercial applications. Such cells may be divided into two types, the open and closed circuit cells. The first is adapted only for intermittent work, such as the operation of electric bells, annunciators, and all other devices requiring a momentary current. The form of open circuit cell used almost universally for this work is the Leclanche (Fig. 5) or some of its modifications. The elements are zinc and carbon, the zinc being in the shape of a rod or cylinder. The carbon in the original form consists of a plate mounted in a porous cell of unglazed earthenware surrounded by a mixture of black oxide of manganese and broken carbon, the top of the cell being sealed up with insulating compound. It is a single fluid cell, using a saturated solution of sal ammoniac. In the more recent forms, the porous cell is dispensed with and the negative consists usually of a carbon cylinder only. Dry batteries, now so largely used, are of this type, but instead of the solution of sal ammoniac, a paste is used and the entire cell is sealed up. Such a cell can be used in any position, and as there is no evaporation it is a very convenient form for light work, but cannot be renewed conveniently when exhausted.

The closed circuit cell is made in several forms, the most familiar being the gravity or sulphate of copper cell used largely for telegraph work (Fig. 6) and described in the last number of this magazine. Another cell largely used for operating telephone transmitters is known as the Fuller. The elements in this cell are known as zinc and carbon. The solution is a bichromate of potash in water to which sulphuric acid has been added. The zinc is cone shaped and placed in the bottom of a porous cell containing mercury and filled with water. The bichromate solution is outside of the porous cell surrounding the carbon. The mercury within the porous cell keeps the zinc constantly amalgamated. The pressure or electromotive force of this cell is only two volts, and it requires but little attention to keep it in good working order. Another well-known single fluid cell is the Grove, using zinc and platinum with a solution of nitric acid and water. The Bunsen cell differs from this only in the substitution of carbon for platinum. Both of these cells have a pressure of about 1.03 volts. There is practically no limit to the combination of metals and exciting solutions which may be used to form a galvanic battery. The above list, however, covers the forms most largely in use at the present time. An alkali solution may be used instead of acid in a battery, and a cell of this type, quite well known, is the Edison-Laland battery, which consists of a plate of oxide of copper for one electrode and zinc for the other. A caustic potash solution is used, which is covered by a layer of heavy oil to prevent evaporation. The electromotive force of this cell is quite low,—about .8 volt,— but as there is no action when on open circuit and the internal resistance of the cell is low, this form of cell is well adapted for operating

small motors and is frequently used for supplying a current for phonographs and slot machines. Before leaving the subject of batteries, the student's attention is directed to the phenomena of polarization, a defect peculiar to nearly all forms of galvanic batteries. This defect may be well shown and easily investigated by taking a single cell of the bichromate battery described and filling the jar with a weak solution of sulphuric acid and water. Now if the two plates are connected by means of a wire, a current is at once developed. In a few moments, bubbles of gas will be noticed on the surface of the two plates, and the current and the strength of the battery will diminish rapidly as the accumulation of gas increases. The cause of this failure of the current depends not only on the weakening of the solution as the battery is in use, but also on the fact that the layer of hydrogen gas on the copper or carbon plate gradually increases the internal resistance of the cell and so prevents the maximum flow of current. In addition to this effect, the hydrogen gas on the negative plate and the oxygen gas on the zinc develop a counter electromotive force or pressure in opposition to the current flowing in the circuit. This failure of the battery is called polarization. If the gas be partially removed from the plates by



Gravity Battery.

shaking the cell or brushing the plates, the strength of the current will rise. In practical use, however, the same result is arrived at by chemical means. In the gravity battery, the hydrogen gas decomposes the copper sulphate, depositing metallic copper on the copper or negative plate, and frees the sulphuric acid, which was part of the copper sulphate, thus continually renewing the surface of the copper and preventing the accumulation of gas. In the Grove and Bunsen batteries, the hydrogen is reduced to water by the nitric

Leclanche Battery.

acid, thus keeping the negative element free. In the Leclanche type, the hydrogen is reduced to water by the oxide of manganese. In the bichromate cell, the chromic acid formed from the bichromate salt performs the same office. A rough means of showing the effect of polarization may be had by connecting an electric bell or the telegraph sounder described in the November number of Amateur Work, including a coil of fine wire or other resistance sufficient to make the bell-sounder work feebly on the single cell with acid solution described. When the plates are first put in the jar, the bell or sounder will work quite strongly, but as polarization increases, the effect will become gradually weaker until finally the instruments will refuse to work.

A railroad company in Pennsylvania prevented the striking miners in its coal mines from interfering with non-union workmen, who were employed in pumping water out of the mines, by building a barbed-wire fence seven feet high about the pump-house and dynamo plant, and then charging it heavily with electricity.

THE COOPER-HEWITT LAMP.

A New System of Electric Lighting.

Within the past few months there has been presented to the public a system of electric lighting which, in point of interest and results, bids fair to equal any improvement in lighting methods put forth in the past few years. This invention, known as the Cooper-Hewitt vapor lamp, was exhibited to the public first at a meeting of the American Electrical Engineers last spring. In construction this lamp differs very strikingly from the familiar incandescent lamp, and its principle of operation is also different from the arc light. The lamp has not yet been developed to a commercial stage, but the experimental period is so far successfully passed as to warrant the assertion that it will be on the market within a comparatively short time. In appearance the lamp consists of a glass tube, nearly an inch in diameter, and about three feet long. The ends of the tube are in some models expanded into bulbs, and in each end of the tube or in each bulb is inserted a single leading-in wire, terminating at upper end in a metal cup-shaped electrode, preferably iron, while on the lower end of the lamp is contained a small quantity of mercury, which is in metallic contact with the leading-in wire at this point. The air is exhausted from this lamp by a process similar to that used in the manufacture of incandescent lamps of the ordinary type. As the air is exhausted, the tube becomes filled with mercury vapor, which at a certain stage or vacuum becomes conducting to a current of relatively low pressure or voltage. In the samples so far exhibited, when connected to a 110 or 220 circuit, this current is first started through the lamp from one end to the other by a special device, when it continues to flow uninterruptedly, and gives rise to an intense light throughout the entire length of the tube, so long as the current is applied to the lamp. The results are practically the same, whether direct or alternating currents are used, although which current is the most satisfactory in commercial practice is not yet announced. The intense light generated by the passage of the current through the rarified mercury vapor is not caused by an arc between the terminals of the lamp, but is a true form of conduction. There is no intense heating of the terminals or the lamp, and there is a dark space around and in front of each electrode. This space and its appearance differ with different vapors used. When the lamp was first shown last spring, it gave a harsh white light. This defect has been overcome by introducing traces of nitrogen with the mercury vapor, which has the effect of imparting a reddish tinge to the light that is very pleasant to the eye. The stability of the light under a constant pressure or voltage seems to be dependent upon maintaining a uniform vapor density or resistance to the current. This again is determined by the amount of heat developed and the rate at which the heat is radiated from the lamp. By suitable proportions of the metal vapor the density of heat radiation is maintained at a constant point, after the lamp has been once started, so that there is no variation in the illumination. During the early experiments with this type of lamp, in order to start the lamp glowing, it was found necessary to heat the lamp to a certain temperature before the current would begin to flow through it. This defect has been eliminated by a discovery that a small quantity of sulphur compound introduced in the lamp would enable the current to start very freely. In addition to this modification, a special starting device is used, by which the current is turned on the lamp, an initial current of high potential is forced through the lamp, when the low tension current will follow it, and the lamp will glow at its full intensity. As there is no solid conductor, such as the carbon filament used in the incandescent lamp, and no carbon electrodes, as in the case of the arc lamp, it would seem as though the Cooper-Hewitt lamp should show a remarkably long life. The efficiency is stated to be much higher than that of any lamp of the incandescent type, and the cost of manufacture is small compared with the results obtained. What the effects of a prolonged test on this lamp are, has not been given out, and it is impossible to state whether it will deteriorate through blackening or discoloring of the glass or decomposition of the light-giving vapors. The method of manufacturing this lamp, described briefly, is as follows: A tube of the proper shape is first cleansed with acids, alkali and water. It is then thoroughly rinsed with dilute hydrofluoric acid, and then washed with distilled water, and is sometimes given further cleansing in a bath of hot hydrogen gas. If mercury is to be used for the

conducting vapor, a small quantity of it is placed in the tube; and if sulphide of mercury is required for forming the starting material, a small amount of this substance is also added. Pure sulphur has been used instead of sulphide of mercury, but it has been found more difficult to reach the desired results than with the mercury salt. The lamp is then connected to an exhaust pump, such as is used in the manufacture of ordinary incandescent lamps, aud while the exhaustion is taking place, artificial heat is applied to the tube in any convenient manner. After the air and other free gases have been exhausted, an electric current of high potential is applied to the terminals of the lamp. The operation of the exhaust pump is continued, and as it approaches completion, a voltage equal to that under which the lamp is to be operated, is applied to the terminals. When the proper stage has been reached, the lamp becomes intensely illuminous owing to the passage of this current, and after some further adjustment the lamp is sealed off the pump, and is ready for use after the connectors and supporting devices have been added. It is impossible to state at this early stage what position the Cooper-Hewitt lamp will occupy in the field of electric lighting. It seems to have advantages over the Nernst lamp in simplicity of construction and the ability to manufacture it for comparatively small candle-power. It does not seem, however, as though it is as practicable of such minute subdivision as the ordinary incandescent lamp, and it is probable that it will be used chiefly for general illumination, thus occupying an intermediate position between the arc and incandescent systems.

At the present time it seems as though a distinct advance has been made in electric lighting, and future developments will be watched with great interest, not only by the general public, but by the manufacturers of electric-lighting apparatus and the central station managers.

Experiment has shown that an electric arc can be employed under water for fusing metal. The intense heat turns the water surrounding the arc into steam, thus forming an insulating cushion of vapor. It has been suggested that with proper apparatus the electric arc could be employed by divers for quickly cutting through large chain cables or iron plates under water.

OLD DUTCH FURNITURE.

John F. Adams.

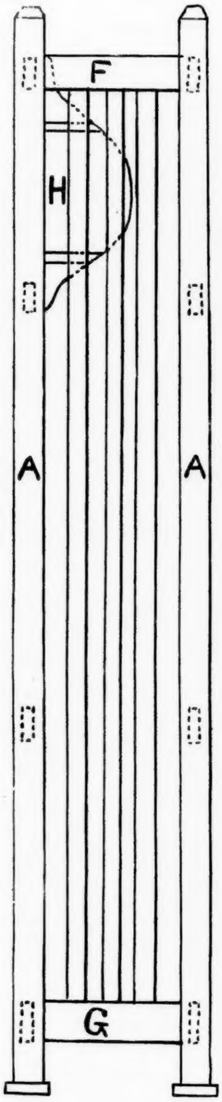
II.

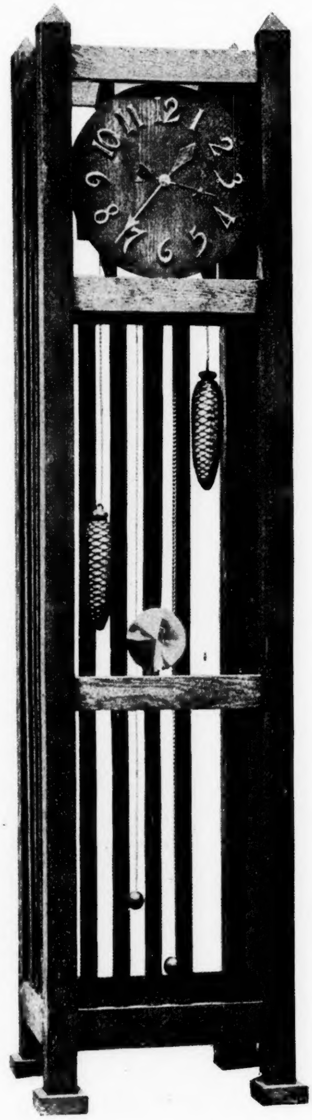
Hall-clock.

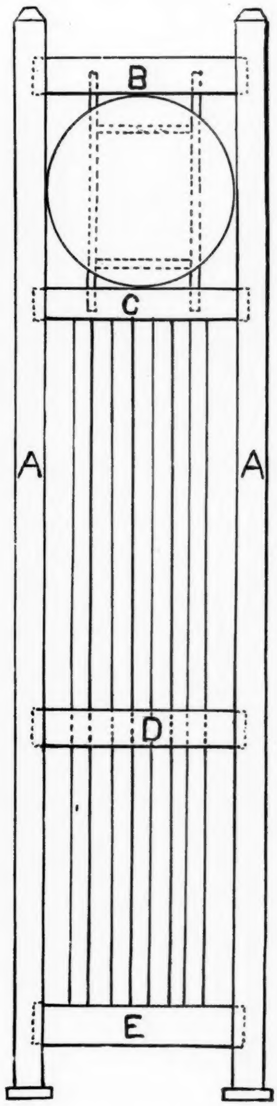
The hall-clock here described is of very striking appearance, and valuable where a strong decorative effect is desired. It is easily made, and will undoubtedly be the subject upon which many readers of this magazine will devote their leisure time during the long winter evenings. This description is limited to the construction of the framework and dial, the works to be purchased. At another time the description will be given of the construction of the works of a wooden clock, suitable for this frame.

The wood for this clock should be selected oak. The four corner-pieces, A, are 6′ 6″ long and $2\frac{1}{8}$″ square. The top ends should have a $\frac{7}{8}$″ bevel, as shown in the drawings. The crosspieces B and C are $2\frac{1}{4}$″ wide and $1\frac{3}{4}$″ thick. The crosspiece D is $2\frac{1}{2}$″ wide, and E is $2\frac{3}{4}$″ wide, and both are $\frac{7}{8}$″ thick. The uprights, A, are 14″ apart, which requires the crosspieces to be 16″ long, thus allowing 1″ on each end for the tenons that fit the mortises in the uprights, A. The crosspiece B is $3\frac{7}{8}$″ below the tops of A; C is 14″ below B; D is $28\frac{3}{4}$″ below C, and E is 19″ below D. These pieces, as well as the crosspieces on the sides, are carefully jointed to A by mortise and tenon joints, the mortises for each crosspiece being centered in A. The front is entirely open, except where the dial is. The back is the same as the front, excepting that the crosspiece D is omitted; and between C and E are fitted four pieces, $1\frac{1}{4}$″ wide and $\frac{7}{8}$″ thick, the space between A and the nearest piece being $2\frac{1}{2}$″, and $1\frac{3}{8}$″ between each piece. Allowing $\frac{5}{8}$″ for tenons on each end of these pieces, they should be $51\frac{1}{2}$″ long. The open space on the back between B and C allows the clock movement to be easily inspected at any time.

The sides have two crosspieces, F and G, only, both being $2\frac{1}{4}$″ wide and $1\frac{3}{4}$″ thick; and allowing 1″ on each end for tenon, are 12″ long, this making the uprights, A, 10″ apart. Three pieces, $1\frac{1}{4}$″ square and $67\frac{1}{2}$″ long, allowing $\frac{1}{2}$″ for tenon on each end, are fitted to mortises in these crosspieces. The outside ones are $1\frac{7}{8}$″ from the uprights, A, and $1\frac{1}{4}$″ apart. Two pieces of board, H, $18\frac{1}{2}$″ long, 6″ wide and $\frac{7}{8}$″ thick, are cut to the shape







shown in the drawing and screwed to the cross-pieces B and C on the front. The dial is fastened to the front edges. They should be placed so as to properly receive the works, which are supported by cross-shelves, the dimensions of which are determined after the works are purchased. Holes will have to be cut in the bottom shelf, to allow the pendulum to swing and the chains for the weights to run through. No difficulty will be experienced in arranging this, if measurements are accurately made. A piece of thin board should be fitted to cover the back of the works, to keep out the dust. The blocks on the bottom of the uprights, A, are $3\frac{1}{2}''$ square and $\frac{7}{8}''$ thick, and fastened to the uprights by wooden pins, glued in. Wooden skewers, used by butchers to dress meat, will answer nicely, four holes being bored in each block, and the upright to receive the pins. Holes for casters may also be bored, and casters fitted when desired, but the clock stands firmer without.

The dial consists of a carefully selected circular piece of oak, 14″ in diameter and ¼″ thick. The figures may be of metal or wood; preferably the latter, using a fret-saw to make them. If of metal, get the fancy-shaped figure used in numbering street doors. Black iron figures can also be used, in which case the dial should be of white oak, and not stained. If wooden figures are used, they should be of very light wood, and glued to the dial after the latter has been stained. The outline of the figures should be marked on the dial before staining, and no stain applied to such places, as it would prevent the glue from holding strongly. To get the figures evenly placed, scribe a circle on the dial with dividers, cutting the bottom edge of 12 and the top edge of 6.

The frame and dial are finished in dark brown or green stain, as preferred, and wax-polished. A bright polish should be avoided, as it is not in harmony with this design. Care should be used in attaching the works that they are level, so as to get an even swing of the pendulum. The pendulum-rod should be stained to match the frame. If the rod is polished metal, a coat of light brown paint should be given it. The stain can then be applied, and the grain effect of wood secured. Careful attention to these directions will enable any one of ordinary skill to construct this very useful, as well as unique, piece of furniture.

HOW TO DEVELOP FILMS.

James F. Lucas.

We will assume that the developing-room is suitably equipped for the work and that the light is safe to work under.

On a bench or table, some distance from the red light, spread a clean paper, and on this place the rolls of film, seeing that each is wound tight as it comes from the camera, to prevent the quite frequent occurrence of fog-marks along the edge of the film.

Just previous to development obtain the following equipment: a pair of scissors, a knife, three large bowls or trays for washing, developing and fixing respectively, preferably 8″ x 10″ in size. Also a supply of fresh developer, a small bottle of potassium bromide solution, 1-10, for emergencies, acid-alum-hypo-fixing solution, glycerin and a clean towel.

With the knife, if necessary, cut away the paster which keeps the roll together. Hold the roll loosely in the left hand, and with the right grasp the free end of black paper and pull the paper out until the film is reached. Then, holding the end of the film and dropping the paper, continue to pull until the entire roll is exposed. Detach the inside end of the film from the black backing with the scissors, leaving the film entirely free. If the film has a scalloped edge, cut off about ⅛″ along its entire length, as the sharp corners will surely cut or scratch the surface before you are through with it.

Without any unnecessary handling, place the film in a tray of clean, cold water, face down, folding it over and over carefully, so as to have no sharp creases. Remove and reimmerse two or three times, to get rid of air bubbles and to partially flatten the film, making it easier to handle in the developer. Never attempt to cut your films apart until they have partially developed, as you are almost certain to cut into some picture. Allow your film to soak a minute, and meanwhile pour into the developing-dish enough fresh, strong developer so that it is at least ½″ deep, and place the same within a couple of feet of the light. Holding the strip by the ends with both hands, lower it, face down, into the tray. Move it to and fro, until every part of the surface has been thoroughly wet with developer. In the course of thirty seconds the images will probably make a faint appearance, when if some show a tendency to lag, while others darken up rapidly, remove the strips to the wash water again, and cut the pictures apart. Replace the slow ones in the developer and continue the process until the images are all out, which will probably take five or six minutes. By this time, even if no more detail can be obtained, the images will grey over, and further action will only block up the shadows and render the films useless. Place these in the wash water, and transfer the remaining films to the now somewhat slower acting developer. If they have the average snapshot exposure and conditions, they will probably develop up in three or four minutes. The back of the film should lose its creamy, yellow appearance and take on a dingy, grey color. Looked at by transmitted light, the image should show good strength and have a somewhat overdone appearance. Transfer to the wash water with the rest.

If, perchance, a few of the pictures show signs of darkening too quickly, which is seldom the case, they may sometimes be improved by washing the developer rapidly off and plunging into a plain solution of the potassium bromide, 1-10, before mentioned, for a few minutes soaking, finally finishing off with the developer well restrained with bromide; *i.e.*, add sufficient bromide solution, varying from a few drops to an ounce, to sufficiently retard the developer. Experience will be necessary to enable this to be correctly judged.

If the strip at the outset comes up uniformly, development may be allowed to continue without cutting, or after cutting the strip in halves for convenience, folding the film over and over without creasing, and continually but carefully changing its position in the developer.

After development is completed, rinse all films well in cold water and transfer to the fixing bath, where they should be kept moving for the first half minute, and thereafter at brief intervals. Peculiar yellow stains are liable to occur if this precaution is not taken, which no subsequent amount of fixing will remove. The films should remain in the fixing bath twenty minutes, and then be removed to cold water to rinse off the hypo-solution adhering, after which they should be washed in running water for an hour. After washing, swab off the surface with cotton, and place in a clean tray of glycerin and water, 1-32, for five minutes. Keep films moving in this as in other baths, for uniformity of results. Swab off once more with cotton, and without washing, drain and nail by the corners to a clean, soft-wood board, inclining the board against the wall on a shelf away from the dust.

If the strip has been developed in one piece, it may be laid over a broom-handle, end to end, film side out, with clip attached to the ends, to prevent curling.

In an hour or two, according to the temperature and humidity of the atmosphere, the films will be dry, and should be wiped off with a soft cloth, cut apart, if this has not been done, and placed between cards cut a little larger than the size of the picture. Mark for reference.

In spite of all care, scratches and pinholes will sometimes occur. They may be partially hidden by laying on the least bit of opaque, with a fine pointed brush, using the color as dry as possible. The prints will likewise require to be spotted, to correspond. To avoid these defects, use solutions cold, select a developer which does not contain a large proportion of alkali, use the acid-alum fixing bath, and handle the films with gentleness all through the process, not crossing them in the solutions, but working them side by side.

Long, fernlike lines extending lengthwise of the film are due to electrical phenomena in the process of manufacture, and cannot be helped. At certain intervals all films have a ridge crossing the film on the back, which may come right over an important picture. The ridge may be ground down with a knife, or some cotton and a little pumice. It is a defect in manufacture, and must be accepted as such. If during development a mealy sort of fog comes out all over the films, they were probably old and stale, or left in a damp place. It is always wise to get the freshest rolls possible, expose and develop expeditiously, and meanwhile keep them away from all abnormal atmospheric conditions. For a developer, the Metol-Hydroquinone is recommended, many formulæ for which are to be found in plate circulars and the photographic magazines. For the beginner, Hydroquinone alone is good, being slow of action and easy to manage.

DECORATIVE EMBOSSING.

An Artistic Yet Simple Method of Decoration.

We are all familiar with the fancy frosting with which confectioners decorate wedding and similar cakes. The utensils used for this work may, with slight modifications, be used to produce very ornamental calendars, photograph-frames, souvenirs, menus, programmes, window signs and other display cards, etc. For relief-map making it is excellent, and adds great interest to the study of geography. A photograph mounted upon heavy cardboard with a calendar pad beneath, and decorated by this process, would make a handsome present for a friend. But little artistic ability is required, the common embroidery patterns being readily adapted for the necessary designs. The process is easily learned if the directions here given are carefully followed.

The necessary articles are a syringe bulb of heavy rubber about two and one-half inches long, a glass tube one-quarter inch outside diameter and pointed at one end, a package of white water-paint,

preferably of the kind known as "Alabastine," several papers of gold, silver and other colored bronzes and flitters, and a saucer or bowl for mixing. With the exception of the bronzes, these materials will cost about fifty cents. The syringe must have a strong suction. For the glass tube, a medicine "dropper" will answer, provided the flange is not so large as to prevent its being easily inserted in the rubber bulb. A better way would be to obtain a short piece of glass tubing, heat it near one end in an alcohol lamp and draw it out to a point. A little practice will soon enable this to be nicely done, and, once learned, the supply and shape of points may be varied as desired. An alcohol lamp may be made from a short, wide-mouthed bottle, through the cork of which a hole is bored with a gimlet or knife, through which is inserted a quill tube cut from a large hen-feather. The cotton wick is put through the tube, and should project a little so the quill will not be burned. The bulb and tubing can usually be purchased at the druggists', and a jeweller will form the glass points if the reader does not care to do it. The water-paint, bronzes and flitters can be secured of a paint dealer, as may also several pans of water-colors. The variety of colors of bronzes and water-colors purchased depends on how elaborately one cares to engage in this work. A good selection would be, one paper each of gold, silver, green, red and blue bronze, gold and silver flitter. Flitter varies from bronze in being flaky, while the bronzes are very fine powder. The appropriate uses of flitter will occur to the reader as progress is made in the work.

The materials are prepared and used as follows: the water-paint and water are first mixed in the proportion of about two parts water to five parts paint, the paint being gradually added to the water until quite pasty.

The proportion varies a little, the paint of different manufacturers not being alike. A little experience will enable the right proportions to be easily found. The rubber syringe is now squeezed flat, the open end inserted in the paste and then allowed to expand, thus becoming filled with the paste. Several insertions may be necessary to completely fill the syringe. When full, the glass tube is then inserted. If the bulb, held in the right hand, is now evenly and gently pressed, the paste will be expelled from the point in a fine round line, which may be guided by the left hand as desired. An even pressure is necessary, otherwise the line will be very uneven, with lumps in one place and nothing in another. Releasing the pressure stops the flow of paste, and this should be done in moving from one part of the work to another. A little practice with lines, curves and letters will soon enable even lines to be made at will. The lines are now white and for some effects are allowed to remain so. If a gold or other color is desired, the bronze is dropped over the work with a smooth table-knife, the work turned at different angles to allow the bronze to reach every part of the paste, then turned over and given a light rap with the knife to detach any surplus bronze and allow it to fall upon a piece of smooth paper used for that purpose. Bronze is not very cheap in price, so care should be taken in saving the surplus. If several colors are desired on the same work, the paste for one color is put on, the bronze of that color applied and the surplus removed. The paste for the next color is then put on, and colored, and this is repeated for each color applied. When white is wanted, in combination with colors, the paste for the white parts is the last to be put on. The work in one color should be perfectly dry before another color is applied, otherwise some of the second color will attach to the work of the first. Letters, half of which are one color and half of another, may be secured by removing the surplus of the first color from one side or end and the other color from the opposite side of the work, thus preventing them from getting mixed. Additional colors and tints may be secured by coloring the water used for mixing the paste with water-color. This is much less expensive than when bronze is used, yet is very useful for display cards. A design thus colored upon cardboard of a lighter tint of the same color may be made very attractive.

The utensils, when through using, should be thoroughly cleaned and keft in a jar filled with water. This prevents the paste from hardening and clogging up the tube and syringe.

The wide range of work possible with this process will become evident to the reader as experience is gained. Panels, screens, dadoes, are but a few of the lines of work, limited only by the artistic ability and desires of those who persevere.

CONCERNING SUPERHEATED STEAM.

Recently public attention has been once more turned in the direction of the use of superheated steam in our engines. The agitation of this question is by no means new. Along about the middle of the past century superheated steam was used to a small extent in several European countries, but was shortly given up. This was because of mechanical difficulties in the way of successful superheating, and not because the advantages in economical running were unnoticed.

Europeans, too, have been more forward in their attempts to utilize superheated steam than have Americans. On this side of the ocean the main object has been to employ saturated steam, and to obtain such a range of expansion as would yield the best results. To this end compounding was resorted to, and few attempts were made to increase the efficiency in any other way.

The steam which is generated in our boilers is, under favorable conditions, saturated steam. But with it it always carries a certain amount of excess moisture. This moisture exists even before the steam leaves the boiler. When it enters the steam main, no matter how excellent the covering, a certain amount of heat will be radiated, and this loss of heat can only result in the condensation of some of the steam. Consequently the amount of moisture is increased. Upon entering the engine cylinder, the walls of which are comparatively cool, there is a further loss by radiation, resulting in still further increase of moisture.

The use of superheated steam will not obviate this loss of heat, but it will reduce it to a great extent. Saturated steam is always of the temperature and pressure of the water from which it is generated, and its heat cannot be added to, while in contact with that water, without increase of pressure and temperature. But if it be led away from the boiler and passed through a series of coils, over surfaces which are heated to a higher temperature than the steam itself possesses, it will receive an addition of heat, without a change of pressure. This is the characteristic of superheated steam. It can be of any pressure and can be raised to any temperature within the limits of the superheating apparatus. In this it differs widely from saturated steam, which follows a certain fixed law in the relation of its temperature and pressure.

Let us follow the course of superheated steam sent from superheater to engine. If the degree of superheat is great, there will be no condensation whatever in its passage through the pipes. There will be a loss of heat by radiation, it is true, but unless this loss of heat reduces the temperature to or lower than the temperature corresponding to saturated steam of the same pressure, there will be no condensation. The same is true when the steam enters the cylinder. So that if the amount of heat added by superheating be equal to or greater than that lost in radiation, and so on, the interior walls of steam pipes, steam chest and cylinder will all be perfectly dry as far as moisture is concerned.

This is an additional advantage. Superheated steam, as the amount of superheat grows higher, approaches more nearly a perfect gas in nature and properties. Owing to this absolute dryness, it is less efficient in conducting heat than is the moisture-laden steam and the wet pipes and cylinder. So that the radiation loss when using superheated steam is much less than with saturated or wet steam.

The superheater consists of a coil or series of coils of pipe placed in the path of the flue gases, through which the steam is forced to pass as it travels from the boiler to the engine. Or the superheater may have an independently fired furnace. The main object, or rather the essential condition, being that the steam to be superheated shall pass through pipes surrounded by gases several hundred degrees hotter than the steam itself.

The reason for requiring such a heat for superheating must be evident. The steam is constantly in motion toward the engine, and so remains in the tubes but a short time. Yet in that time it must reach a certain temperature. This requires a high degree of temperature outside the tubes.— *The Practical Engineer.*

It is said that experiments with the Delany telegraph system will be carried on by the Pennsylvania Railroad. With this system it is possible to transmit 8,000 words a minute, while a commercial rate of 2,000 words a minute is said to be possible with a single copper wire. With this system perforated tape is used, the characters being recorded electrolytically on tape which has been chemically prepared.

AMATEUR WORK

85 WATER ST., BOSTON

F. A. DRAPER . . . . Publisher

A Monthly Magazine of the Useful Arts and Sciences. Published on the first of each month, for the benefit and instruction of the amateur worker.

Subscription Rates for United States, Canada and Mexico, $1.00 per year. Single copies of any number in current volume, 10 cents.

TO ADVERTISERS

New advertisements, or changes, intended for a particular issue, should reach the office on or before the 15th of the previous month.

DECEMBER, 1901

Contents

		Page
Studies in Electricity,	*Donald M. Bliss*	25
The Cooper-Hewitt Lamp		29
Old Dutch Furniture (A Hall Clock)		30
How to Develop Films	*James F. Lucas*	32
Decorative Embossing		34
Concerning Superheated Steam		35
Mechanical Drawing	*Earnest T. Child*	37
Astronomy for December	*Vega*	42
The Telescope		43
Picture Decoration		48

TO OUR READERS.

The interest shown in the first number of Amateur Work by numerous patrons is very gratifying to those interested in its publication. We are sure this interest will be sustained by this and future issues. The field is a broad one, and will be carefully developed by experienced writers. Many interesting subjects are being investigated, and will eventually find an appropriate place in our pages. The constant endeavor will be, to so present the various topics as to stimulate the interest of our readers to attempting work that will afford them instruction and pleasure. Many young men idle away time which could be profitably spent in following work here presented. No one can tell when the knowledge acquired at leisure may prove of marked value in the business life.

Electricity is now so much a part of many kinds of business, that the "Studies in Electricity," if carefully followed, should be of great practical value. The successive chapters of this series will afford an opportunity for study, the equivalent of which can be obtained only from a technical school or from books costing many times the subscription rate of this magazine. The construction work and experiments to be presented are progressive, and in harmony with the development of the subject.

The chapters on "Mechanical Drawing" will give the student practical instruction in actual drafting-room practice. The separate parts, and finally an assembly of an upright steam-engine, are the subjects to be presented, together with much general information. The value of a knowledge of mechanical drawing, to any one engaged in manufacturing, cannot be overestimated. To apprentices in machine and electrical shops this opportunity for self-education should be welcome. Students in schools where this is not taught should likewise find these papers of grest value.

The many complimentary letters received from readers in widely separate parts of the country are an evidence that this magazine is providing for a want on the part of young men which hitherto has been unsupplied. We shall greatly appreciate any assistance that these readers can render towards giving it wider publicity and patronage.

The news that the New York elevated railway lines will, within a few months, be equipped with electric power, will be welcome to the many thousands who travel on them daily.

MECHANICAL DRAWING.

EARNEST T. CHILD.

II.

CONVENTIONAL PROBLEMS.

In our last talk we described the instruments which are necessary for the mechanical draftsman. Having secured the complete set or, if needs be, a partial set, the student should accustom himself to handle them properly. To learn to use dividers correctly will require some little practice, and the execution of a few conventional problems will be found the most satisfactory way in which to familiarize one's self with them. The following geometric problems have been selected from a large number, being the most important, as they cover the principles which apply to all.

Problem 1.

To draw parallel lines. Draw the line AB. At A, with radius R, draw an arc xx, and at B, with the same radius, draw arc yy. Draw line CD which shall be tangent to both arcs, just touching them. Line CD will be parallel to AB.

Problem 2.

To erect a perpendicular, bisecting a given line. On the line AB with center A and any radius, more than one-half AB, strike arcs xx and yy. With center B, and same radius, cut arcs xx and yy at 1 and 2. Draw CD through points 1 and 2. This line will be perpendicular to AB, and midway between points A and B.

Problem 3.

To erect a perpendicular at the end of a line. On line AB with A as a center and any radius construct arc xy. With center y and same radius cut xy at 1. With 1 as a center and same radius draw arc zz. Draw line from Y through intersection 1, and cut zz at 2. Draw lines AC through point 2. This line will be perpendicular to line AB.

Problem 4.

To construct a square. Proceed as in problem 3 to erect a perpendicular at A. With radius equal to AB cut vertical line at C. With center C and same radius strike arc xx. With center B, and same radius cut arc xx at D. Draw lines BD and CD. Fig. ACDB is a square.

Problem 5.

To construct an equilateral triangle. Draw line AB of the proper length for one side of the triangle. With radius AB and center A strike arc xx. With same radius and center B cut xx at C. Draw AC and BC, making triangle ABC, which is equilateral and also equiangular. By taking radii of the proper length, any triangle may be constructed in a similar manner. For instance, if AB =6 inches, AC=4 inches and BC=5 inches, radius for arc xx will be 4 inches, and radius for arc to cut it at C will be 5 inches.

Problem 6.

To construct a circle on any three points, given the points ABC. Draw lines AB and BC. Erect perpendiculars at centers of these lines as per problem 2. Construct these perpendiculars until they meet at point O. With O as a center and radius OA, draw a circle, and it will be found to pass through points B and C.

Problem 7.

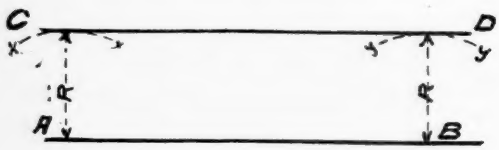
To construct a trefoil. Draw an equilateral triangle as per problem 5, and bisect each side as per problem 2. Then with the apex of the angles as centers and radius equal to one-half the sides draw arcs xy, yz and zx. In a similar manner a quarterfoil may be drawn about a square.

Problem 8.

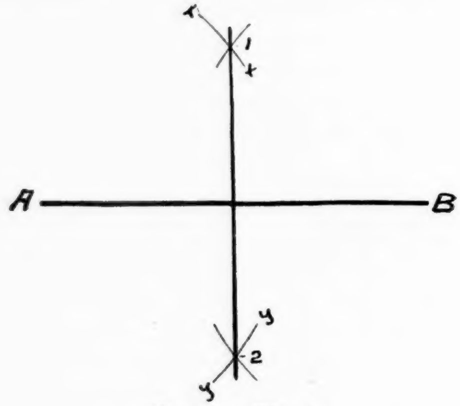
To divide a straight line into a number of equal parts. Draw AB, and set off AC as an acute angle. Lay off on AC a number of equal lengths equal to the number into which the line is to be divided, say six. Draw B 6, and then draw lines 5-5, 4-4, 3-3, 2-2 and 1-1 all parallel to B 6, as in problem 1. These lines will divide AB as required.

Problem 9.

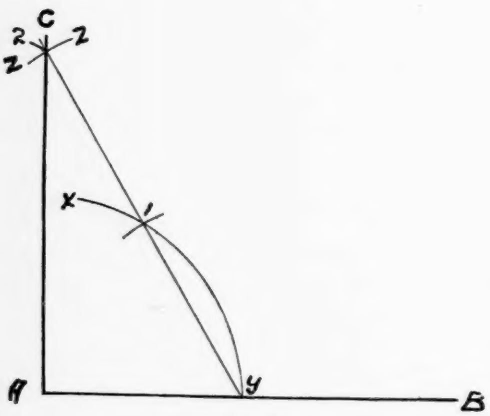
To inscribe a polygon of any number of sides



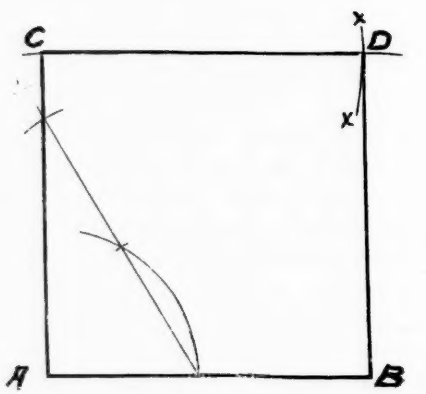
Problem No. 1.



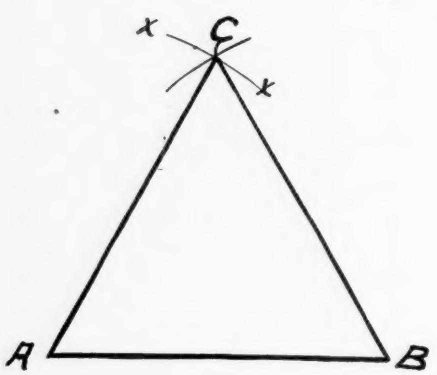
Problem No. 2.



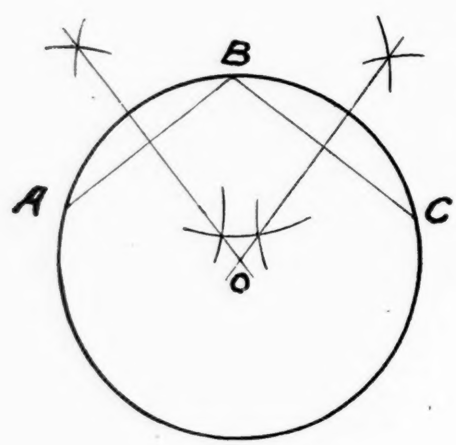
Problem No. 3.



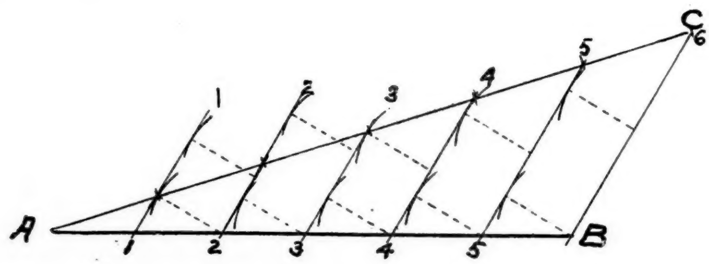
Problem No. 4.



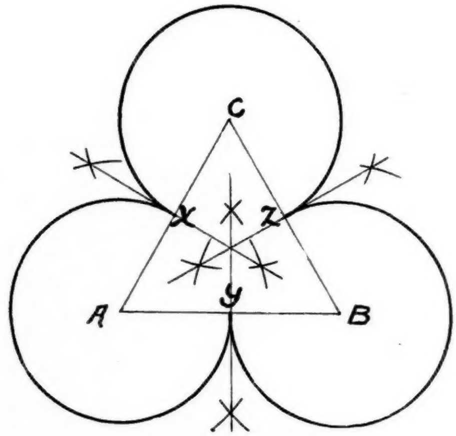
Problem No. 5.



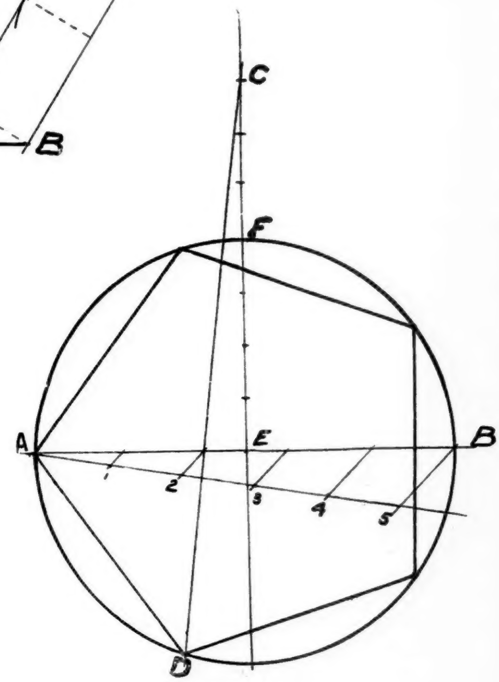
Problem No. 6.



PROBLEM No. 8.



PROBLEM No. 7.



PROBLEM No. 9.

within a circle. On center E draw a circle, and draw diameter AB. Through center E erect the perpendicular EC, cutting the circle at F. Divide radius EF into four equal parts, and lay off FC equal to three of them. Divide diameter AB into as many equal parts as the polygon has sides, and draw line CD through the second point from A, cutting the circle at D. Then AD is equal to one side of the polygon, and by stepping with the dividers around the circumference with the length AD, the polygon may be completed.

The student should work out the above problems carefully, drawing with pencil first, and then tracing his work in ink on tracing-cloth, preferably using the dull side of the cloth. It is a common mistake in schools to have the pupil ink in his work on paper; and while a very neat drawing is almost always the result, the pupil does not get the practice which he should have in the use of tracing-cloth. The use of paper for finished drawings has been practically abandoned in most drawing-rooms, and the cloth tracing stands as the record drawing. Thus the student is handicapped, as his work as a beginner in a drafting-room is invariably tracing on tracing-cloth from a pencil paper drawing, and unless he has had previous experience in using it he will surely find great difficulty in so doing. The writer's experience with beginners has been that they know absolutely nothing of the use of tracing-cloth, and blots, erasures, and even holes through the cloth are the not infrequent trials of the beginner, and his employer. It should be impressed on the student's mind that a thorough knowledge of the use of tracing-cloth is very essential to his success as a draftsman.

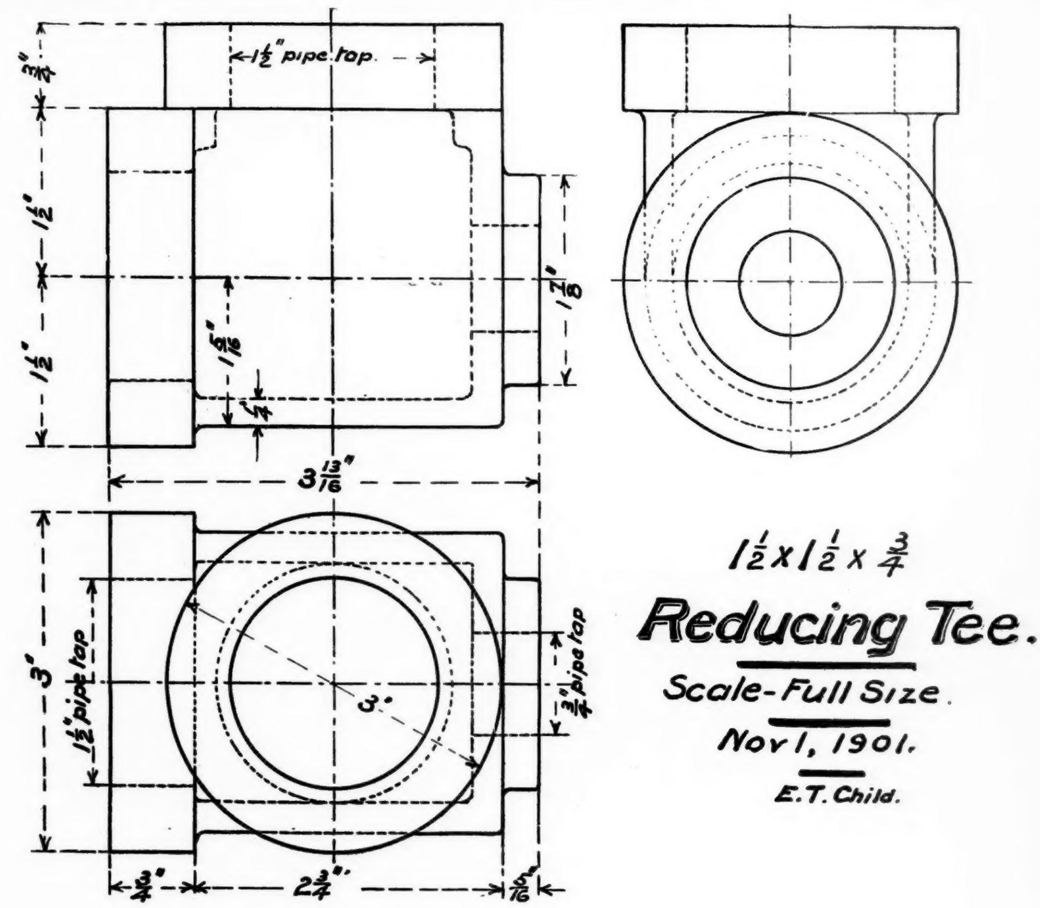
To make the ink flow well, the cloth should be well rubbed with powdered chalk or talcum, which should be carefully wiped off with a cloth. This will remove any oily particles which would tend

to prevent the ink from flowing upon the surface evenly. To make the cloth lie flat, the selvage edge should be torn off. The cloth should be well tacked to the board, the thumb-tacks being not over ten to twelve inches apart. In erasing, care must be taken not to spoil the surface of the tracing, and a knife should not be used except for very fine work, and when used it must be extremely sharp. The safest way is to use a sand rubber, even though it erase more than necessary. It will not destroy the surface, and after a little powdered talcum has been well rubbed on the erased part, it may be inked again as well as at first. If tracing-cloth is not available, the paper drawings may be inked in, thus giving an idea of the use of drawing ink.

In completing the various problems, the construction lines may be drawn in full red lines, or in fine full or dotted black lines, the finished lines being drawn strongly in black. In later and more advanced work, construction lines are omitted. Before any ink work is done, at least one sheet should be made for practice in using the ruling pen, using various widths of line, dotted, dot and dash, and dash lines, to accustom one's self to the behavior of the drawing ink and ruling pen. It will be well to attempt drawing lines tangent to circles, which may also be drawn for practice. As previously stated, Whatman's paper is most commonly used for school work, and this undoubtedly makes the neatest looking drawing; but if tracing-cloth is available, manila detail paper will be preferable, as it is more commonly used in drawing-rooms, and the student can be working on the line of future practice. The cost of tracing-cloth is higher than Whatman's paper, and therefore it will be well to adopt a standard size of sheet as small as convenient. AMATEUR WORK is $7\frac{3}{4}''$ x $10\frac{5}{8}''$, and this is about the size of a standard letter sheet. If we adopt a standard $7\frac{1}{2}$ x $10\frac{1}{2}$ single and 15 x $10\frac{1}{2}$ double, it will work out very nicely. Manila paper may be obtained 22 x 30 (which will make four standard sheets) at about 60 cents per quire. This is about three standard sheets for two cents. Tracing-cloth may be obtained 30″ wide at about 28 cents per yard, and a sheet 22 x 30 will cost about 18 cents, which is $4\frac{1}{2}$ cents per standard sheet. The practice sheet may be used to help in learning the use of triangles and tee square, in drawing horizontal and vertical lines without having to use the problems which have been given above.

Having become fairly accustomed to the use of instruments, the next step will be to make a drawing showing three views of some simple object. Before this is done, a brief explanation of the rudiments of projection will be necessary. A mechanical drawing is never a picture, nor a perspective view. It is assumed that the eye is directly over each point of the object at the same time, and the dotted line is used to show parts which are hidden from external view. In other words, a mechanical drawing shows an object as if it were transparent or as if the X-rays were thrown on it. It must not be loaded with unnecessary detail, but it must contain enough to convey to the workman the necessary information to complete the work which it depicts. A simple object may be shown by two views, but it is customary to always show three views, and where the object is very irregular, additional sectional views may be taken.

A convenient arrangement places the plan in the lower left-hand corner of the sheet, with a front elevation directly above it, and an end view on the right. This leaves space for the title in the lower right-hand corner, where it is most conveniently seen as the sheet lies in the drawer. There is no established standard as to arrangement of views, but this has been found very convenient. The sheet should be numbered in the lower right-hand and upper left-hand corners, so that in case it gets into the drawer inverted, its number may be easily seen. The views must be placed in projection; that is, the center line of the front elevation will be directly above that of the plan, and that of the side view will be exactly in line with that of the front view and to the right. Let us take for our first regular drawing a steam-pipe-reducing tee. First locate the main center lines and begin to block out the views, carrying all three views along as closely as possible, as errors are more readily detected than when the views are finished separately. When the outlines of all three views are complete, then fill in the dotted lines and details, and finally line the pencil drawing in, preparatory to tracing. The drawing is now ready for the figures. Too much stress cannot be placed on the importance of this part of the work. A drawing may be perfect so far as lines and scale are concerned, yet may be entirely



SHEET PLAN (Reduced One-Third).

ruined by the use of crude or irregular figures. Great care must be used to make the figures well and of uniform size, and this part of the work should never be hurried. It will be well to check every figure by scale after the drawing is completed. Center lines are shown by dot and dash black lines, or full red lines, and usage differs regarding dimension and witness lines, but a dash black or a full red is the most common. Full red lines are preferable, as they show less strongly on a blue print, and a full line may be made more readily than one which is dotted. Dimension lines should be broken to allow space for the figure. Arrow or witness points should be made long, and at an angle of about 45 to 60 degrees, never wider, and the point of the witness mark should just touch the lines to which the dimension is given. The over-all dimension should be given where there is a series of subdimensions, to insure an additional check on the work. There are other important points regarding the figuring of drawings, which will be brought out from time to time as illustrations may arise. As stated above, the title should be placed in the lower right-hand corner of the sheet, and should designate the name of the whole, the special detail which may be represented, the scale, the date of completion, and the name of the designer, engineer or draftsman. Plain type should be used. The writer's experience goes to show that an Italic, Gothic letter entirely devoid of flourish is most readily handled by the largest number of draftsmen.

ASTRONOMY FOR DECEMBER.

On the 1st of December the sun sets at 4 h. 13 m. P.M., Standard Time (Eastern). A trail of planets follows after him in a regular crescendo of brilliancy. Mars, setting at about six o'clock, will, from its lowness in the haze, be difficult to see, except with a telescope. Saturn, about forty minutes further east, is followed by Jupiter, only a minute behind, and less than half a degree south, so that both will be in the same telescopic field with a power of thirty, and will continue so for at least a week.

Venus will have passed the two and will be fifty minutes further east, being near her greatest eastern elongation, which occurs on the 4th of the month. So that for a short time after sunset the twilight sky will be graced by the three principal planets in a row, each brighter than the one next west of it; a beautiful sight. Unfortunately they will be too low in the south for good definition in the telescope, though the contrast in the brightness and color of Jupiter and Saturn will be very evident, as long as they remain in the same field.

On the morning of the 1st, Mercury will be a little more than an hour east of the sun, and five degrees north of it, so that though it will probably be invisible to the naked eye, any one having a clear horizon and circles to his telescope may be able to pick it up between six o'clock and sunrise.

The sky at eight o'clock in the evening on the 1st of December will be very nearly the same as described for midnight of the 1st of November, with the exception that all the constellations will be about an hour further east, so that the two Dogs will not have risen. No planets will be visible, all having set, and the moon, being near her third quarter, will not rise for nearly three hours.

The moon will be absent from the evening sky until the 11th or 12th of the month, as she will be twenty days old on the 1st. She passes her last quarter on the 2d, and is new on the 10th; is at the first quarter on the 18th, and fulls on Christmas Day.

The early evenings of the month, therefore, will afford excellent opportunities for the study of the winter constellations. Orion, Gemini, Taurus and Aries are all up in the east, the former two stretching along horizontally from southeast to northeast, Taurus above them, and Aries above Taurus.

In the east, and to the north of Taurus, are Auriga and Perseus. The constellations above enumerated contain a great many stars of the first three magnitudes, in beautiful and striking configurations, and make the eastern sky very brilliant.

There will be eight stars of the first magnitude above the horizon; namely, Betelgeuse (Orion), Rigel (Orion), Aldebaran (Taurus), Capella (Auriga), Deneb (Cygnus), Vega (Lyra), Altair (Aquila), Fomalhaut (Pisces Austrinus): an hour or so later these will be reënforced by the arrival of Sirius and Procyon in the east.

Here the reader may very naturally ask, "What is a magnitude?" a question which it is not quite a simple matter to answer to his comprehension.

To an astronomer or physicist it would be comprehensively answered by the statement that a magnitude is that ratio between the light of two stars which is expressed by the number whose logarithm is 0.4. For the lay reader the most satisfactory way of explaining the question is to go a little into the history of the subject.

The early uranographers divided the stars visible to them into six classes or magnitudes, rather roughly defined, from the first, which included about a dozen of the very brightest, to the sixth, which were the faintest that a good eye could certainly distinguish on a clear night. Each magnitude was approximately half as bright as the next above it. While the stars were only roughly mapped and studied with the naked eye, it was sufficient.

But with the advent of the telescope the extension of the scale downward at once began to be a matter of difficulty. Men began to estimate half-magnitudes: the absence in the small field of the telescope of a number of standards of comparison, such as were available in naked-eye classification, made the estimation a matter of memory and judgment, and also greatly increased the difficulty of maintaining a constant value for the ratio expressed by the word magnitude. Struve, the

Russian observer, and after him others, began to estimate tenths of magnitudes. Each observer used a scale of his own, without much reference, apparently, to those of others.

From this resulted a great confusion of magnitudes in the catalogues which were brought out during the early half of the last century. The first to begin to reduce this chaos to something like order was Argelander of Bonn, in his great survey of the northern heavens, which included practically all the stars down to the ninth magnitude, and a great many yet fainter, and extended from the north pole to one degree south of the equator. Each star was observed three times, and as the catalogue when complete included 110,985 stars, it will be seen what an enormous labor it was. Each star when observed for position had an estimate of its magnitude recorded at the same time, and each magnitude in the catalogue represented the mean of three estimates, made by men experienced in this particular work. A great point was made of keeping to a constant ratio in the magnitudes, this ratio to be as nearly as possible that of the old naked-eye scale. The magnitudes in this catalogue (called the Bonn Durchmusterung) were at once accepted by American astronomers, and have been the standard to which all later attempts to reform the scale of magnitudes have been referred. Webb ("Celestial Objects," page 207, 4th ed.) gives a very interesting table, comparing the telescopic scales of several eminent observers with this "DM" scale, as it is called, which it would repay the reader to look up.

While Argelander was at work on this catalogue, the early experiments in stellar photometry were being made by Zöllner and others. In the seventies and thereafter, with the introduction of serious photometric work on the stars, in Pritchard's labors with the "wedge" photometer at Oxford, and Pickering's with the "meridian" photometer at Cambridge, an attempt was made by the astronomers and physicists interested in the question to unite upon a definite standard ratio, on which all photometric work should be based. The ratio finally adopted, as representing the scale heretofore used among the naked-eye stars, was the one first stated; viz., that number whose logarithm is 0.4, which is 2.52; so that a star is very nearly twice and a half brighter than those of the next magnitude below it.

As this ratio is a geometric one, it follows that a first-magnitude star is twice and a half brighter than a second, six times brighter than a third, sixteen times brighter than a fourth, forty times brighter than a fifth, and so on, until at the ninth it is four thousand times brighter.

Deneb in the Swan, and Altair in the Eagle, are good types of first-magnitude stars. Such stars as Sirius, Capella and Vega are much brighter than this, and their magnitudes are expressed in the photometric scale by decimals less than one; or if the difference is more than a full magnitude, by negative values; *e.g.*, Capella, 0.24; Vega, 0.10; Sirius, —1.72.

In the six ordinary naked-eye magnitudes, Heis enumerates 1,380 stars as being visible in these latitudes; the numbers in the several grades are: first to second, 13; second to third, 48; third to fourth, 152; fourth to fifth, 313; fifth to sixth, 854.

VEGA.

THE TELESCOPE.

REFRACTOR AND REFLECTOR.

DURING the last half-century we have been so saturated with wonderful discoveries and inventions that we can form but a faint idea of the sensation produced in the minds of the people of the seventeenth century by the discovery of the telescope. Great discoveries, such as have crowded upon us so rapidly since the invention of the electric telegraph, were then few, and separated by centuries instead of by months as now.

How great must have been the wonder excited by this seeming reversal of the laws of nature, the apparent annihilation of distance by this marvelous instrument, most of our readers can probably have but a faint idea.

The writer has some realization of it, his surprise, wonder and delight at his first clear sight through a spyglass, at the age of nine, being still fresh in his memory.

Galileo has commonly had the credit of the discovery. But the idea was suggested previously by Kepler, and it is very probable that the Italian's invention was at least stimulated by seeing mention of the general principle, possibly in a letter from Kepler, with whom he corresponded.

As it happens, however, his invention was paralleled, if not anticipated, by two spectacle-makers in Middelburg, Holland, Zachariah Jansen and Hans Lipperheim, who independently made the same invention, except for the use of a convex instead of a concave eyeglass. But Jansen and Lipperheim are not such picturesque historical figures as Galileo, and so their fame has not lived as has the latter's.

The two forms are optically different, Galileo's, with the concave eyeglass *e*, as shown in the diagram, Fig. 1, intercepting the rays from the objective *o*, before they come to the focus, and making them parallel by bending them *out*, so that the only real image is formed within the eye.

Jansen's and Lipperheim's, on the other hand, using the convex eyeglass, placed beyond the focus of the objective at a distance equal to its own focal length, magnifies the image formed at that focus, rendering the rays parallel by bending them *inward*. (Fig. 2.)

FIG. 1.

Both these forms, in their essentials, survive in modern practice, Galileo's in the opera and field glasses, and Lipperheim's in the modern refractor, whose furthest point of growth is now the Yerkes equatorial.

FIG. 2.

The Galilean telescope had the defect, inherent in its construction, of possessing a very small field of view, which more than offset its sharper definition, so that it was soon dropped in astronomical practice, and the Dutch arrangement became practically the only one in use.

It was soon found that the prismatic effect of the lenses limited the possible aperture of the objective

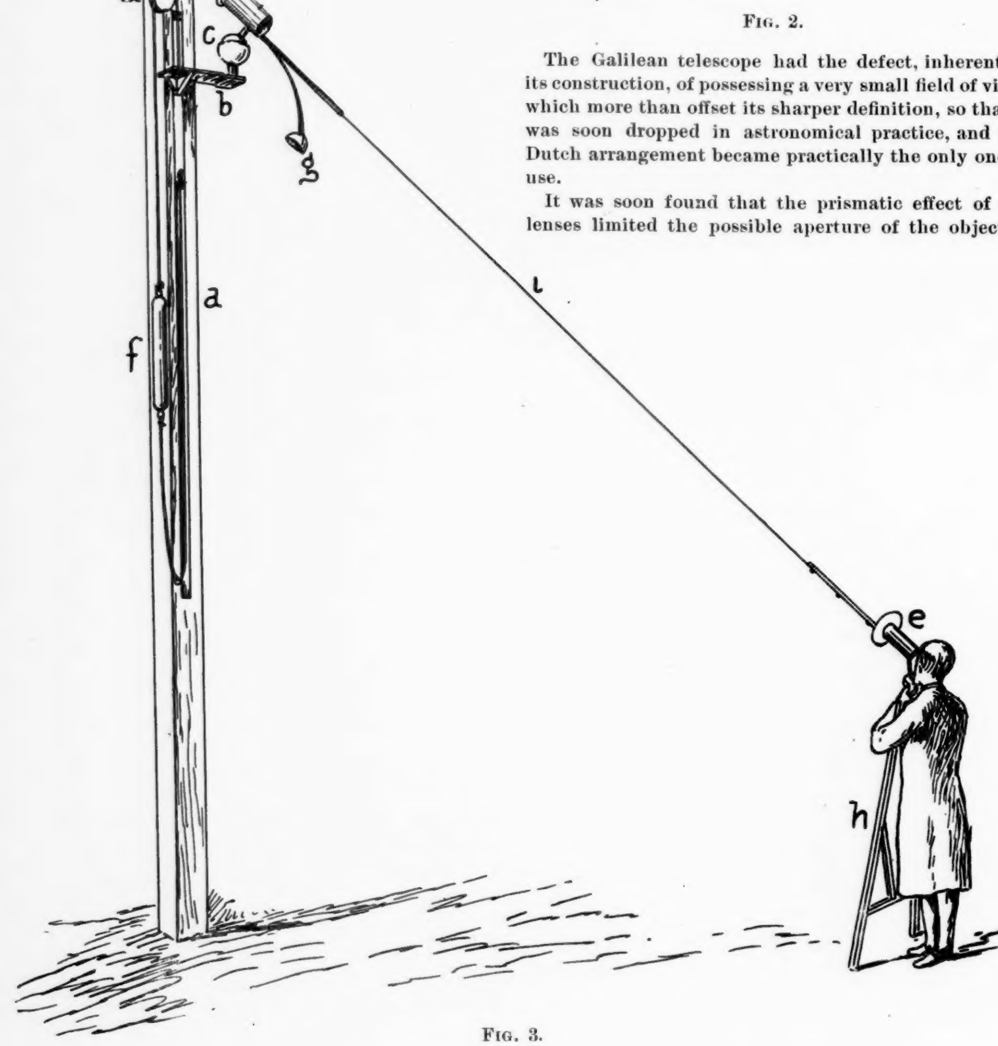


FIG. 3.

and power of the eyeglass, so that to obtain, for instance, a power of fifty, it was necessary to have a telescope six feet long, whose objective was limited to 1.32″ in diameter; astronomers mentioned the length of the telescope employed in any given observation, as indicative of the power used, and this practice continued even as late as the middle of the nineteenth century, although its force as indicating power was entirely obsolete.

So the telescopes lengthened out in search of power, until the devices for handling the tube and keeping it from bending under its own weight became so heavy and unwieldy that observing with them was almost impossible.

Huyghens, who, besides being an astronomer, was, for those days, an excellent mechanical engineer, invented an arrangement for using the telescope without a tube. The objective, set in a short tube, mounted on a ball-and-socket joint, was arranged so as to be raised and lowered on a tall pole; the axis of the short tube was controlled by a long cord, so that another short tube, carrying the eyeglass and held in the hand, could be brought into line with it. The illustration, Fig. 3, shows the appearance of one of these telescopes. *aa* is the post, *b* the bracket carrying the objective, which is mounted on the ball-and-socket joint *c*, and balanced by the weight *g*. The bracket and its load are counterpoised by the weight *f*, which is carried on an endless cord passing over the pulley *d*. The observer leaned on the rest *h*, and controlled the objective and kept it in line with the eye-tube *e*, by the cord *i*. The image of the object was received on the cardboard disc shown at the front end of the eye-tube, and the latter directed into place by an assistant.

With an instrument of this kind Huyghens discovered the fourth satellite of Saturn, and determined the form of his ring, which was before unknown; and Cassini discovered three other satellites of the same planet, and made his other discoveries, with such telescopes.

With such an equipment, observing must have been a terrible labor, and all these discoveries were made at such cost of toil and exposure as would daunt most modern observers.

These telescopes were made of dimensions up to 150 feet in length, and Auzout, of Paris, is said to have made an object-glass of 600 feet in focal length, but there is no record of its ever having been mounted for any useful observations.

The difficulties of observing with such glasses set the wits of many scientific men to work to find a remedy. Sir Isaac Newton and others attempted to solve the problem of making an object-glass free from color, but all failed, the difference in the refractive qualities of different kinds of glass being then unknown. Newton then turned his attention to the use of mirrors, and in 1672, with his own hands, made two small reflecting telescopes; these were about six inches in focal length, and one of them bore a power of 38, about equal to that of a four-foot refractor of that time. The performance of these instruments left something to be desired, as Newton, though, as he says, he approved the parabolic figure, knew no way of producing it, and had to content himself with spherical curves, which do not produce a perfect image. One or both of these telescopes is still in existence in the collection of the Royal Astronomical Society, if I am not mistaken.

The form of telescope devised by Newton, and ever since known by his name, is that now commonly used for reflectors, and is shown in the diagram below.

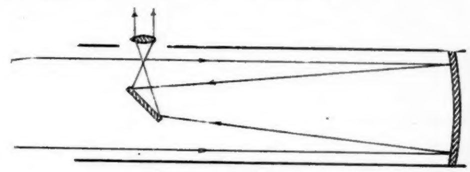


FIG. 4.

Where *a* is the large mirror, or speculum, as it is generally called, *b* the diagonal mirror, now usually referred to as the flat, and *c* the eye-piece, the course of the rays is shown by the arrows; the same remark applies to the other diagrams of reflectors.

The mirrors were made of speculum metal, an alloy of copper and tin, very white, hard, and brittle, and of high reflective qualities, taking a very perfect polish.

Gregory and Cassegrain invented forms in which one looked apparently directly through the tube, as in the refractor; this, however, was only apparent, and was accomplished by placing a small speculum, concave in Gregory's form (Fig. 5), and convex in Cassegrain's

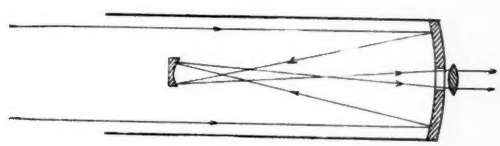


FIG. 5.

(Fig. 6), near the focus *o* of the great speculum, so that the rays were reflected directly back through a hole in

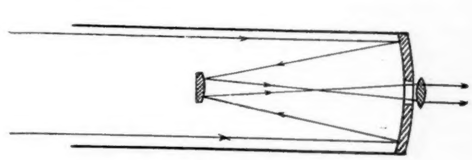


FIG. 6.

the center of the latter, to the eye-piece. These were powerful for their size, and handy to use, but were expensive, and were finally crowded out by the improved refractors of the next century.

The reflector has certain advantages over the refractor; there being but one large surface to be worked,

instead of four, a perfect performance can be obtained at much less expense. All the rays can be brought accurately to the same point, as is not the case in the refractor, as will be shown farther on. The image at the focus of the speculum is absolutely free from extraneous color, being formed by reflection.

In point of convenience the reflector has one very great advantage, that the eye-piece is situated, not in the prolongation of the main tube, but at right angles with it, so that the observer, instead of having to hold his head in constrained and uncomfortable positions when viewing objects at high altitudes, can always, by rotating the tube in the cradle with which it is generally provided, keep the eye-piece in such a position that he can look into it as he would into a microscope, at the angle that best suits his convenience. Any one who has had to make careful estimates of magnitude, or to try to make out delicate planetary detail with a refractor, at an altitude within a few degrees of the zenith, or even to observe at those intermediate elevations where the eye-piece is just too low to get at comfortably when standing, and just too high to be reached without stretching up from any available seat, will understand how great and substantial an advantage this is.

When you add to this that about double the power can be had at the same cost, it will be seen that there are real advantages to be urged by the advocates of the reflector.

For fifty years the reflector remained the best telescope to be had. But the difficulty of obtaining suitable metal for the specula for many years hindered its progress; besides that, the processes for producing the best figure seem for a long time to have been kept secret in a few hands, so that they were very expensive instruments, and their size and power were limited.

Besides, the metal used reflected only about seventy-five per cent of the light, so that with two reflecting surfaces, and the light stopped by the small speculum, only half the light which entered the tube was finally available for purposes of vision, while the refractor utilized about ninety per cent of the light.

The refractor, however, was limited by the spherical aberration of the lenses of which it was made, that is, the impossibility of bringing all the rays to a single point by means of lenses made on spherical curves, and many attempts were made to obviate this by modifying these curves; but it was found that the chromatic aberration, caused by the action of the glass in separating the light into its component colors, was a much greater defect, as every bright object was bordered by a fringe of these colors, increasing rapidly with the increase of aperture and convexity of the lenses.

In 1729 Mr. Chester More Hall, of More Hall near Harlow, in Essex, England, succeeded in accomplishing the desired result, and is said to have made several telescopes. But he did not make his discovery public, and the matter went no farther.

In 1747 Euler tried a lens compounded of glass and water, "but," says Chambers, "it was a signal failure."

In 1758 Dollond invented the combination of flint and crown glass now in use, for which he received the Copley Medal from the Royal Society.

The rationale of Dollond's invention is as follows: If two similar glass prisms are placed in the path of a beam of light, with their refracting angles in opposite directions, the rays of light, which are separated into their primary colors by the first prism, in virtue of its dispersive power, and bent aside by its refractive power, will be refracted to the same extent in the opposite direction by the second prism, so that the beam will issue from it with its direction unchanged, and still white, the action of the first prism having been exactly reversed by the second.

Now a lens is similar in its action to a prism, the only difference being that its surfaces are curved instead of straight; so that if we have a convex and concave lens of similar glass and equal curvatures, the beam of light will, in passing through both, be bent out of its path and dispersed, as the separation of the colors is called, to precisely the same extent by both lenses, but in opposite directions, so that it emerges unchanged.

The optical glass of which all lenses are made is of two different kinds, called crown and flint glass. The latter has a refractive power slightly greater than that of the crown; its dispersive power is about three times as much greater as its refractive. Says Dr. Dick: "The edges of the lenses, one of crown and the other of flint glass, may be considered as two prisms which refract contrary ways, and if the excess of refraction in the one be such as precisely to destroy the divergency of color in the other, a colorless image will be formed. Thus if two lenses are made of the same focal length, the one of flint and the other of crown, the length or diameter of the colored image in the first will be to that produced by the crown as three to two nearly. Now if we make the focal lengths of the lenses in this proportion, that is, three to two, the colored spectrum produced by each will be equal." (I am not responsible for the good doctor's English, but his idea is clear enough.) "But if the flint lens be concave, and the crown convex, when placed in contact they will mutually correct each other, and a pencil of white refracted by the compound lens will remain colorless."

It also happens that when the flint and crown lenses are adjusted to best accomplish this result, the spherical aberration is also perfectly corrected, and the convexity of the crown lens is greater than the concavity of the flint to such an amount that the combination is virtually convex, and the rays form an image at its focal point.

This correction, however, is only approximate, though a close approximation, as the extreme rays of the spectrum cannot be brought to absolutely the same focal point by any combination of flint and crown lenses, though an infinity of approximations, all equally close,

is possible; the problem is therefore what is mathematically called an indeterminate one.

In practice the curves are so computed as to bring the rays of greatest light intensity and the extreme rays together, so as only to lose those of least illuminating power.

There is always, therefore, in the achromatic, a fringe of violet light about the image of a bright object in focus. This is called technically the "outstanding light," a term the reader will often meet with in the literature of the telescope, and it is never wholly absent; this causes no difficulty in practice, as the eye very soon becomes accustomed to it, and disregards it, so that we actually do not see it unless we look for it.

The exact curves are different with different makers, each of whom has his favorite "formulas," as an indefinite number of different modifications will all be equally satisfactory in practice.

The early achromatics were very expensive, but in spite of this they made their way, and in a hundred years had practically crowded the reflector out of the field. But, about 1864, Foucault, of Paris, made some specula of glass, coated by an electrolytic process with a film of pure silver, which reflects as much light as an achromatic objective transmits. These specula were very satisfactory.

FIG. 7.

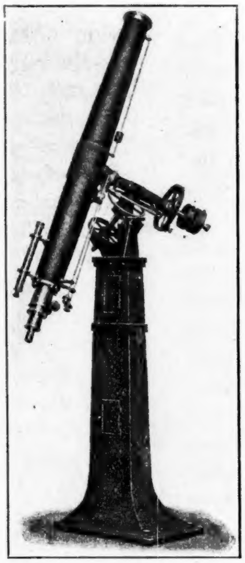


FIG. 9.

FIG. 8.

Since that time the reflector has steadily developed, and is now again a formidable competitor for favor with the refractor. Fig. 7 represents a modern 6½-inch reflector of American make, on a plain stand fitted for general planetary and star-gazing work; price, $250.

Fig. 8 is a three-inch refractor by Clark, on a corresponding stand; price, $150.

The reflector, however, has nearly four times the power of the refractor.

Fig. 9 represents a complete modern six-inch equatorial refractor, with circles, clock, etc. In such an instrument the mounting is often made by one firm, and the optical parts by another. The price of a refractor like this is about $1,500. The corresponding reflector would cost about $650.

Until 1830, a six-inch refractor was a large telescope, and an eight-inch a very large one. The Harvard Observatory fifteen-inch was a monster when made. Later advances in the manufacture of optical glass have extended the possible aperture to the forty inches of the Yerkes telescope, and this is very likely not the limit in this direction; though from the increasing engineering and other difficulties, this seems to be possibly the limit of useful increase.

The large reflectors of Herschel and Rosse were scarcely more than costly experiments. The Rosse specula were confessedly defective in definition. A French astronomer, who was shown Saturn with the great six-foot, said: "They showed me something, and said it was Saturn, and I believed them." Dr. Common, in England, however, has made silvered glass specula of three and five feet aperture, for photographic purposes, whose performance is understood to be excellent.

It will be seen that the beginner's choice between the two types is a difficult one, and it becomes more so the more he knows about the matter, as the advantages are pretty evenly divided. One is very likely to become accustomed to his first choice, and prefer it to the other, and to advise other seekers for information according to his prejudices. Either type is good, and the question practically resolves itself in the end into one of personal taste, and length of purse. VEGA.

PICTURE DECORATION.

This is a process for transferring *printed* pictures to boxes, furniture or other wooden surfaces. Some quite artistic and pleasing effects have been secured by this process. To illustrate how it is done, I will describe the decoration of a box used to store shoes and rubbers. The box was made of clear-grained whitewood of a light color. The corner joints were beveled, to make them show as little as possible. The surface of the wood was nicely sandpapered. The box was then varnished with spar-varnish. The pictures, before applying to the box, were moistened with water by dipping until all the paper was quite moist. Before the varnish was dry the pictures were placed upon the several places selected for them, face to the varnish, and carefully smoothed with a cloth so that all parts of the picture was in contact with the varnish. The pictures and varnish were then allowed to thoroughly dry. When dry, water was again applied to the back of the picture and the paper carefully removed, many applications of water with a sponge being necessary before all the paper was removed. Small pieces that were rather firmly attached to the varnish were taken off with very fine sandpaper. The ink of the printed picture was then found to stand out in clear contrast with the background of light wood, but in reverse view of the original. Coarse-lined pictures were used, such as Gibson drawings from *Harper's Weekly*. A large picture was the front centerpiece, small ones were in each corner; the lid had a similar number, each end had two or three. Border lines were secured from the borders of advertisements cut from magazines.

The process is not difficult, and, with a smaller subject, would be a quick one. The principal points requiring care are: to select proper pictures and get a good grade of varnish; to see that the pictures are well attached to the varnish.

W. B. G.

SENSIBLE BRIC-A-BRAC.

Everyone who has read Wm. D. Howells' "Hazard of New Fortunes" will recall the flat-hunting experience of the couple from Boston when they came to New York to launch a new journalistic venture, and their horror of one furnished flat in particular. This flat was so filled with bric-a-brac, spinning-wheels and vases that Mr. March, the man in the case, promptly dubbed it the "gimcrackery," and he continued to call it by this name until (and here is a moral) he rented it. Of course to be consistent he packed a lot of the "gimcracks" in barrels and stored them away somewhere out of sight, but the fact remains that the "gimcrackery" must have seemed the most homelike flat he visited.

That is the primal object of bric-a-brac. It makes *the* home *our* home. These small, or even large, decorative accessories are in a way the outgrowth of the lares and penates of the old Romans. In fact, some of the very clay images that the old Romans used as their household gods, now grace the cabinets and mantels of our own homes. But art objects have another use. They are the final touch, the bit of addition that makes or unmakes all the rest.

We are, happily, past the days of decorative rolling-pins and metamorphosed banjos, and all that sort of ugliness, but there is quite as much room for improvement as there ever was. This is evinced by the great lot of trash that is sold every year by the "fake auction" Japanese stores alone. Bric-a-brac should be purchased not because it is cheap and not because it is expensive, but because it completes a decorative whole, or gives a decided pleasure in itself. It need not be useful in the usual sense,— for to give pleasure to the eye is certainly a high usefulness,— but it should not be useless, unmeaning or obtrusive.

— *The Upholstery Dealer.*

While everybody has been predicting the ubiquity of the electric automobile as soon as the proper storage battery is devised, the fact that another interesting automobile application of electricity will be equally as much stimulated by such a battery, has generally been lost sight of. Just so surely as the electric automobile will be the favorite both for business and pleasure uses, so the electric boat will take the place of the gasolene, naphtha and steam yacht on our waters when the storage battery enters into its kingdom.

A railroad train in India ran into a herd of wild elephants, and brought to a very sudden stop. One elephant was killed and seven others ran away.